ITRI626/ITRW878 (Kunsmatige Intelligensie / *Artificial Intelligence)* - Toets 3 / *Test 3* -13/10/2015

<u>Vraag 1 (Kwantifiseerders) / *Question 1 (Quantifiers)*</u>

Gee die detail betekenis van die Eerste-orde logika sin $\forall x\ P$, waar *P* enige logiese uitdrukking is. / *Give the detail meaning of the First-order logic sentence* $\forall x\ P$*, where P is any logical expression.* [6]

The expression $\forall x\ P$ *is true is a given model (1 mark) if P is true in all possible extended interpretations (1 mark) constructed from the interpretation (1 mark) given in the model (1 mark), where each extended interpretation (1 mark) specifies a domain element to which x refers (1 mark).*

<u>Vraag 2 (Kwantifiseerders) / *Question 2 (Quantifiers)*</u>

Voltooi die volgende tabel van De Morgan se reëls vir kwantifiseerders. *Complete the following table of De Morgan's rules for quantifiers.* [4 x 2 = 8]

∀x ¬P	≡	(a)
(b)	≡	∃x ¬P
∀x P	≡	(c)
(d)	≡	¬∀x ¬P

	≡	(a) ¬∃x P
(b) ¬∀x P	≡	
	≡	(c) ¬∃x ¬P
(d) ∃x P	≡	

<u>Vraag 3 (Die gebruik van Eerste-orde Logika) / *Question 3 (Using First-order Logic)*</u>

Gee die ses (Peano) aksiomas wat die natuurlike getalle asook die optelling daarvan definieer. / *Give the six (Peano) axioms that define natural numbers as well as the addition thereof.* [10]

NatNum(0) (1 mark)
$\forall n\ NatNum(n) \Rightarrow NatNum(S(n))$ (2 marks)

$\forall n\ 0 \neq S(n)$ (1 mark)
$\forall m, n\ m \neq n \Rightarrow S(m) \neq S(n)$ (2 marks)

$\forall m\ NatNum(m) \Rightarrow +(0,m) = m$ (2 mark)
$\forall m,n\ NatNum(m) \wedge NatNum(n) \rightarrow +(S(m),n) = S(+(m,n))$ *or* (2 marks)
$\forall m,n\ NatNum(m) \wedge NatNum(n) \Rightarrow (m + 1) + n = (m + n) + 1$

<u>Vraag 4 (Inferensie met Eerste-orde Logika) / *Question 4 (Inference in First-order Logic)*</u>

Definieer Veralgemeende Modus Ponens. / *Define Generalized Modus Ponens.* [6]

For atomic sentences p_i, p_i' and q, (1 mark) where there is a substitution θ (1 mark) such that SUBST(θ, p_i') = SUBST(θ, p_i) for all i (1 mark),

$$\frac{p_1', p_2', \cdots, p_n', (p_1 \wedge p_2 \wedge \cdots \wedge p_n \Rightarrow q)}{SUBST(\theta, q)}$$ (3 marks)

<u>Totaal [30] / *Total [30]*</u>